1. If the ambient pressure at the peak of Olympus Mons on Mars (altitude 24,000 m) is 0.02 that at the surface, what is the scale height of the atmosphere? What will the pressure be at 5000 m?

2. Describe the process by which a satellite in low earth orbit acquires a negative electric charge.

3. List the five separate environments which together make up the space environment.

4. For each of the neutral and plasma environments, list *one* effect of the environment which the spacecraft designer must address.

5. For each of the two environments, list *two* design guidelines for that environment.

6. The International Space Station is a negatively grounded structure with a solar array delivering 160 V. If one-quarter of the solar array is positively biased with respect to the plasma (i.e. collecting negative ions), what will be the potential difference between the plasma and the space station fuselage?

7. A free object with a potential that floats with respect to the plasma will typically charge to about -2 V. An astronaut returns to the International Space Station from the ram direction after an untethered extra-vehicular activity. The outermost layer of the spacesuit is aluminized mylar .01 mm thick with a dielectric breakdown strength of 10^5 V/cm. Will the astronaut be able to return to the Space Station without sustaining damage to the suit?

8. Modern electronic devices have dimensions so small that the passage of a single charged particle may be enough to alter the operating characteristics of the device in question. (TRUE/FALSE)

9. Three processes are responsible for the absorption of photons (gamma rays or X-rays) in matter. The conversion of a photon into an electron and a positron in the vicinity of a nucleus is called _____. The elastic scattering of a photon by a free electron is called _____. The absorption of a photon by an atom with the subsequent ejection of an orbital electron (ionization) is called _____.

10. The three naturally occurring sources of radiation in space are _____, _____, and _____.

11. A visible confirmation of the trapping of magnetic particles in the geomagnetic field is the _____.

12. Define *orbital debris*.

13. Astronauts flying through the South Atlantic Anomaly have reported "seeing" charged particles. (TRUE/FALSE)

14. At least two solar proton events have been recorded which were intense enough to be lethal for unprotected astronauts outside of the Earth's magnetosphere. (TRUE/FALSE)

15. Describe the mechanism that traps particle radiation in the geomagnetic field. Outline in detail the motion of a single charged particle in this field.

16. Under what circumstances would you choose to use gallium arsenide or indium phosphide semiconductor technology rather than silicon?

17. How are the characteristics of hypervelocity impact dependent on impact velocity?

18. What is a Whipple shield and how does it work?

19. Most micrometeoroids originate from _____, or _____.

20. What is ASTM E 595? Define TML, CVCM, and WVR. What are the pass/fail criteria for TML and CVCM?

21. Explain the difference between alpha, beta, and gamma rays.

22. The TOPEX-Poseidon satellite is in polar orbit. On several occasions while passing through the "South Atlantic Anomaly" the satellite has spontaneously and unexpectedly shutdown requiring a system reboot. What causes this?

23. Tests of nuclear bursts in space were conducted in the 1960s. The radiation belts were significantly altered with the effects still detectable ten years later. (TRUE/FALSE)

24. Show how to convert MeVs to Joules.

25. Galactic cosmic rays originate outside the solar system in _____.

26. Describe two options for spacecraft disposal at end-of-life and explain why anyone even cares.

27. Assume a satellite charges to -2 V. If the satellite has a surface area of 100 m^2 and dissipates 3.1×10^{-3} J during electrostatic discharge to the plasma, what is the Debye length for this situation?

28. Calculate the decrease in intensity of 4.8×10^{18} Hz X-rays due to 3 cm of aluminum shielding.

29. Assuming that solar irradiance is $(1.0 \times 10^{-6}$ W-nm/$m^2)(\lambda - 2000$ nm$)^2$ between 400 and 600 nm, calculate the ratio of the number of photons with wavelength between 400 and 500 nm, to the number of photons with wavelength between 500 and 600 nm.

30. An object will absorb heat from the sun according to the relation

$$Q_{in} = \alpha_s A_n S,$$

and generate heat internally from fuel cells at the rate

$$Q = N(P_0 - \beta p T^2).$$

The object will radiate heat to the environment according to

$$Q_{out} = \epsilon A_{tot} \sigma T^4.$$

Find the equilibrium temperature of this object.

31. Protons from a solar flare are approaching your orbit at 10^5 km s^{-1} at an angle of 30° to the ambient 0.1 Gauss magnetic field. Calculate the increase in kinetic energy acquired by the protons as they pass through the magnetic field to your spacecraft.

32. Find the number of photons per second arriving in a beam of light with flux $S(\lambda) = a\lambda + b$, assuming that $S(\lambda)$ is measured in W cm^{-2} μm^{-1}.

33. The atmosphere of Mars is almost entirely CO_2. Derive a temperature dependent expression for scale height in such an atmosphere, assuming an ideal gas, hydrostatic equilibrium, and the fact that the acceleration due to gravity at the surface of Mars is 38% of that on Earth.

34. Verify the vector identity $(\mathbf{A}\times\mathbf{B})\cdot\mathbf{A} = 0$.

35. Perform the integration

$$\int\int \frac{y\,dx\,dy}{(x^2+y^2+z^2)^2}.$$

36.